

CLAIMS

1. Membrane electrochemical generator (1, 100, 200) fed with gaseous reactants and comprising a multiplicity of reaction cells (2, 201) being delimited by conductive bipolar plates (3, 203) among which is comprised a proton-exchange membrane (4, 204), characterised in that said conductive bipolar plates (3, 203) comprise a multiplicity of fluid injection calibrated holes (20, 230) for the injection of a calibrated flow of a cooling fluid inside said reaction cells (2, 201).
2. Generator according to claim 1, characterised in that each of said reaction cells (2, 201) is formed by an anodic chamber (9) and a cathodic chamber (10) separated by said membrane (4, 204), said anodic chamber (9) and said cathodic chamber (10) each comprising an electrically conductive reticulated element (7, 206) at whose interior said calibrated flow of said cooling fluid partially evaporates simultaneously providing for the humidification of said gaseous reactants and for the thermal management of said membrane electrochemical generator (1, 100, 200).
3. Generator according to claim 1 or 2, characterised in that said fluid injection calibrated holes (20, 230) are mutually aligned and placed in correspondence of feed openings (12, 13, 208a1, 208a2) for feeding said gaseous reactants and of side openings (16, 209) for feeding said cooling fluid (12, 13, 208a1, 208a2) and said side openings (16, 209) being obtained in a perimetrical portion (11, 208) of said conductive bipolar plates (3, 203).

4. Generator according to anyone of claims 1-3, characterised in that said fluid injection calibrated holes (20, 230) have the same diameter comprised between 0,2 mm + 1 mm.

5. Generator according to anyone of the previous claims, characterised in that said conductive bipolar plates (3) are interposed between a pair of sealing gaskets (8a, 8b) of two adjacent reaction cells (2), said sealing gaskets (8a, 8b) each realising a seat for a respective electrically conductive reticulated element (7) and comprising:

- respective feed openings (8a₁, 8a₂, 8b₁, 8b₂) for the passage of said gaseous reactants;
- respective side openings (8a₅; 8b₅) for the passage of said cooling fluid;
- respective distribution channels (21a, 23a) to connect said respective feed openings (8a₁, 8a₂, 8b₁, 8b₂) to said respective electrically conducting reticulated element (7).

6. Generator according to claim 5, characterised in that at least one of said sealing gaskets (8a, 8b) comprises respective fluid collection channels (22) connected to said respective side openings (8a₅, 8b₅), said fluid collection channels (22) being interposed between said respective feed openings (8a₁, 8a₂, 8b₁, 8b₂) and said respective distribution channels (21a, 23a) and being suited to collect said cooling fluid.

7. Generator according to claim 5 characterised in that at least one of said sealing gaskets (8a, 8b) comprises respective fluid collection channels (22) connected to said respective side openings (8a₅, 8b₅) and to said respective

distribution channels (21a, 23a), said respective fluid collection channels (22) being interposed between said respective feed openings (8a1, 8a2, 8b1, 8b2) and said respective distribution channels (21a, 23a) and being suited to collect said cooling fluid.

8. Generator according to claim 6 or 7, characterised in that in a filter-press configuration said fluid collection channels (22) present on at least one of the sealing gaskets (8a, 8b) are superposed to said fluid injection calibrated holes (20) and that each of said fluid injection calibrated holes (20) is in correspondence of a distribution channel (21a, 23a) obtained on the other sealing gasket (8a, 8b).

9. Generator according to anyone of claims 1-4, characterised in that it comprises a multiplicity of additional cells (101), each of the additional cells (101) being interposed between a pair of reaction cells (2), realising a seat for a respective electrically conductive reticulated element (7) and comprising a perimetrical portion (102a) in which are obtained:

- side openings (104) for the passage of said cooling fluid;
- at least one fluid collection channel (106) connected to said side openings (104) and suited to collect said cooling fluid;
- feed openings (103a₁, 103a₂) for the passage of said gaseous reactants;
- discharge openings (103b₁, 103b₂) for discharging the reaction products and residual reactants.

10. Generator according to claim 9, characterised in that said fluid collection channel (106) is placed below said feed openings (103a₁, 103a₂).

11. Generator according to claim 9 or 10, characterised in that, in a filter-press configuration, said fluid collection channel (106) is superposed to said fluid injection calibrated holes (20) of said conductive bipolar plates (3).

12. Generator according to claim 9, characterised in that said fluid collection channel (106) is formed by a first and a second side portion (107, 108) placed above said discharge openings (103b₁, 103b₂).

13. Generator according to claim 12, characterised in that said cooling fluid, prior to reaching said fluid injection holes (20), crosses the whole surface of said respective electrically conductive reticulated element (7) pre-heating counter-currently or concurrently with respect to at least one gaseous flow entering said reaction cells (2).

14. Generator according to anyone of claims 1-4, characterised in that said conductive bipolar plates (203) comprise a multiplicity of first calibrated holes (213a) for the passage of said gaseous reactants and a multiplicity of second calibrated holes (213b) for the discharge of reaction products and of optional residual reactants and that said multiplicity of fluid injection calibrated holes (230) are placed in correspondence of said multiplicity of first calibrated holes (213a).

15. Generator according to claim 14, characterised in that said first calibrated holes (213a) are mutually aligned and placed in correspondence of said feed openings (208a₁, 208a₂) of said conductive bipolar plates (203) and that said second calibrated holes (213b) are mutually aligned and placed in

correspondence of discharge openings (208b₁, 208b₂) obtained on said perimetrical portion (208) of said conductive bipolar plates (203).

16. Generator according to claim 14 or 15, characterised in that said reaction cells (201) comprise a sealing gasket (207) covering only one face of said perimetrical portion (208) of said conductive bipolar plates (203), said sealing gasket (207) realising a seat for a respective electrically conductive reticulated element (206).

17. Generator according to anyone of claims 14-16, characterised in that it comprises a multiplicity of additional cells (202), each of the additional cells (202) being interposed between a pair of reaction cells (201) and comprising a rigid perimetrical portion (202a) and a hollow central portion (202b), said rigid perimetrical portion (202a) acting as separating surface for said gaseous reactants and said hollow central portion (202b) realising a seat for a respective electrically conductive reticulated element (206).

18. Generator according to claim 17, characterised in that said rigid perimetrical portion (202a) is provided with feed openings (214a₁, 214a₂) for feeding said gaseous reactants, of discharge openings (214b₁, 214b₂) for discharging the reaction products and the residual reactants and of side openings (215) for the passage of said cooling fluid.

19. Generator according to claim 17 or 18, characterised in that said rigid perimetrical portion (202a) is covered on each face by a gasket (217), said gasket (217) defining on each face of said rigid perimetrical portion (202a) a zone of collection of the gaseous reactants (218a) placed in correspondence of

said feed openings (214a₁, 214a₂) of said rigid perimetrical portion (202a), a zone of collection of the reaction products and of the residual reactants (218b) placed in correspondence of said discharge openings (214b₁, 214b₂) of said rigid perimetrical portion (202a), a feed channel (219) to connect one of said feed openings (214a₁, 214a₂) to said zone of collection of the gaseous reactants (218a), a discharge channel (220) to connect said zone of collection of the reaction products and of the residual reactants (218b) to one of said discharge openings (214b₁, 214b₂).

20. Generator according to claim 19, characterised in that said gasket (117) seals said zone of collection of the gaseous reactants (218a) and said zone of collection of the reaction products and of the residual reactants (218b) so as to hinder the passage of said gaseous reactants and of said reaction products and optional residual reactants within said additional cell (202).

21. Generator according to claim 19 or 20, characterised in that in a filter-press configuration said zone of collection of the gaseous reactants (218a) is superposed to said first calibrated holes (213a) and said zone of collection of the reaction products and of the residual reactants (218b) is superposed to said second calibrated holes (213b).

22. Generator according to anyone of claims 19-21, characterised in that said fluid injection calibrated holes (230) are placed below said first calibrated holes (213a) and that said gasket (217) defines on each face of said rigid perimetrical portion (202a) a fluid collection channel (221) placed below said feed openings (214a₁, 214a₂) of said additional cells (202).

23. Generator according to anyone of claims 19-21, characterised in that said fluid injection calibrated holes (230) are interposed between said feed openings (208a₁, 208a₂) of said bipolar plates (203) and said first calibrated holes (113a, 113b) and that said gasket (217) defines on each face of said rigid perimetrical portion (202a) a fluid collection channel (221) interposed between said feed openings (214a₁, 214a₂) of said additional cell (202) and said zone of collection of the gaseous reactants (118a).

24. Generator according to claim 22 or 23, characterised in that in a filter-press configuration said fluid collection channel (221) is superposed to said fluid injection calibrated holes (230).

25. Generator according to anyone of claims 19-21, characterised in that said additional cells (202) comprise a first and a second fluid collection lateral channel (222, 223) connected to said side openings (215) of said additional cells (202) and placed above said discharge openings (214b₁, 214b₂) of said additional cells (202) and that said cooling fluid, prior to reaching said fluid injection holes (230) passes through said first and second fluid collection lateral channel (222, 223) to cross subsequently the whole surface of said respective electrically conductive reticulated element (206) pre-heating counter-currently or concurrently with respect to at least one gaseous flow entering said reaction cells (201).

26. Generator according to anyone of claims 19-21, characterised in that said additional cells (202) comprise:

- a first and a second fluid collection lateral channel (224, 225) connected to said side openings (215) of said additional cells (202) and placed above said discharge openings (214b₁, 214b₂) of said additional cells (202);
- a third and a fourth fluid collection lateral channel (226, 227) connected to said side openings (215) of said additional cells (202) and placed below said feed openings (214a₁, 214a₂) of said additional cells (202);
- a fluid collection channel (221) interposed between said feed openings (214a₁, 214a₂) of said additional cells (202) and said zone of collection of the gaseous reactants (218a) and connected to said side openings (215) of said additional cells (202);

and that said cooling fluid, prior to reaching said fluid injection holes (230) enters through said first and second fluid collection lateral channel (224, 225) to subsequently cross the whole surface of said respective electrically conductive reticulated element (206), pre-heating counter-currently or concurrently with respect to at least one gaseous flow entering said reaction cells (201), said cooling fluid subsequently exiting from said third and fourth fluid collection lateral channel (226, 227);

and that in a filter-press configuration said fluid collection channel (221) is superposed to said fluid injection calibrated holes (230).

27. Generator according to anyone of the previous claims, characterised in that said cooling fluid is liquid water.

28. Membrane electrochemical generator, substantially as described with reference to the annexed figures.